

# Social and Policy Issues in Nanotechnology

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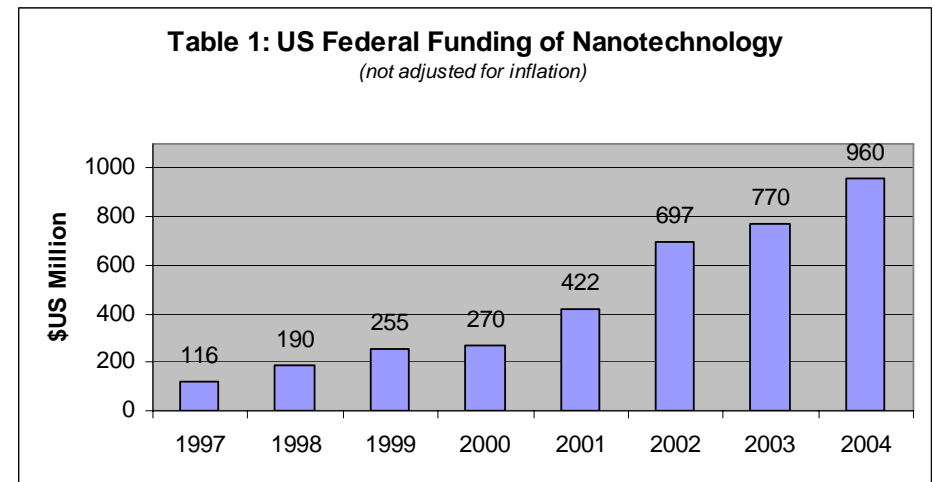
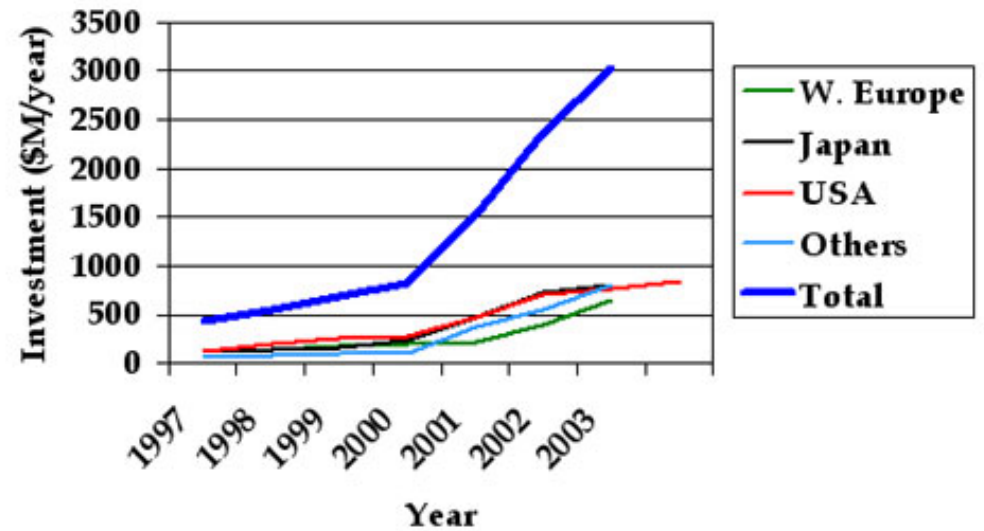


# Outline

- Political Context
  - Two Trends
- Societal Issues
  - EHS
- Governance Charge
  - Integration
- Discussion:
  - How should CLINT engage in these issues?*

# Politics of Competitiveness

- Next Industrial Revolution
  - \$1 Trillion market by 2015
  - \$1 Billion US Federal
  - Largest initiative since Apollo
- Global Competition
  - 30 national programs
  - US lacks the “commanding lead” of previous megatrends (Roco, 2003)
  - “US is being outpaced by foreign competition” (Marty, 2003)
- Policy context
  - High stakes, expectations and visibility



# Politics of Acceptance

- Role of public perceptions
  - Public funding
  - Regulatory environment
  - Commercial adoption
- Potential for public “backlash”
  - GM agriculture, Nuclear Power
  - National Academy, Royal Society, Swiss Re
- Early indicators
  - Active NGOs, authors, celebs
    - ETC, Greenpeace, T.H.R.O.N.G., Bill Joy, Prince Charles, Michael Crichton
  - Public opinion surveys
    - Lack of trust correlated to heightened risk perception (Cobb & Macoubrie, 2004)
  - Sociological “fear factors”
    - Low scores for nano



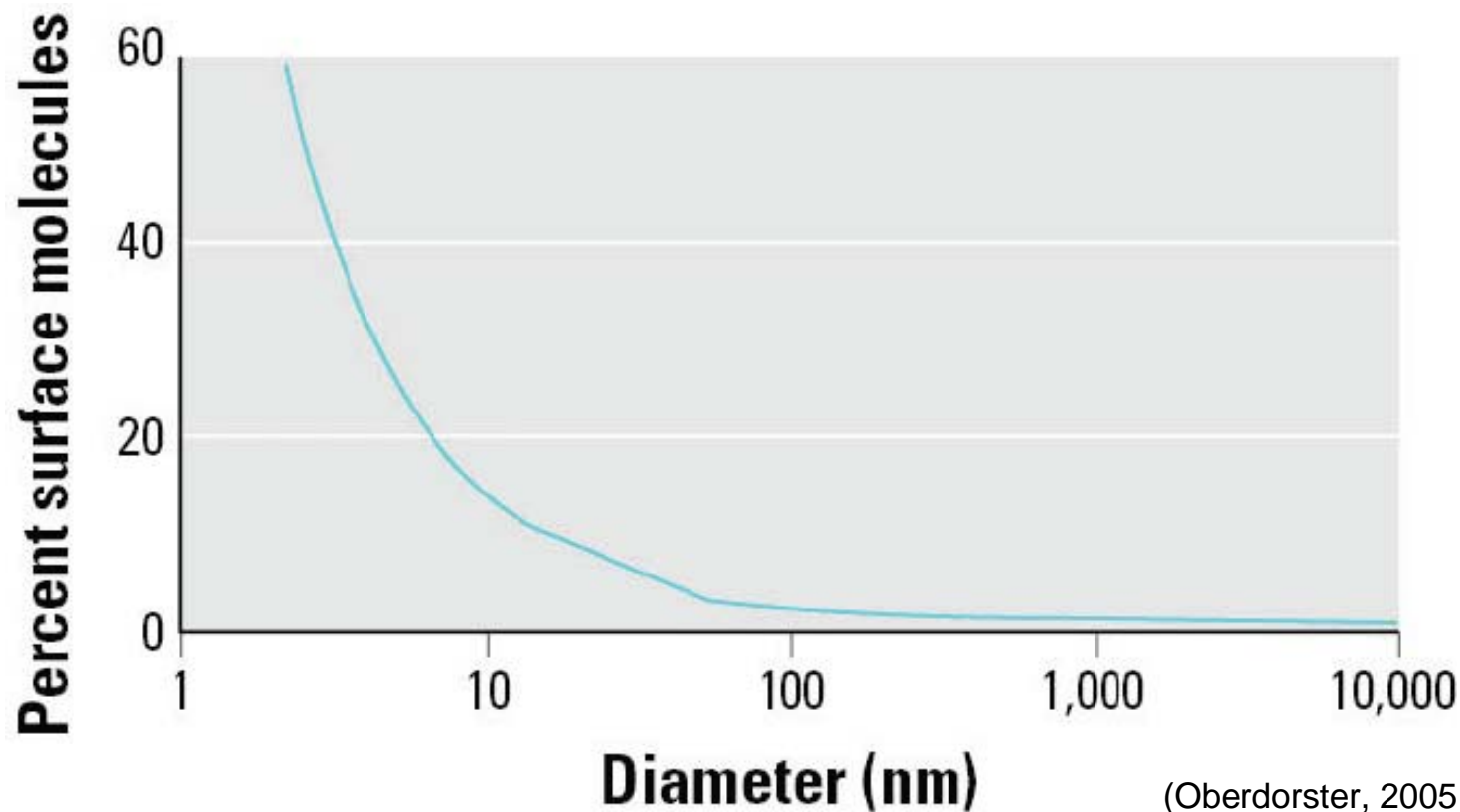
# Perceptual fear factors

- Involuntary
  - Consumers likely to use products containing nanomaterials without knowing it
- Arises from unfamiliar or novel sources
  - Novelty is a standard claim, public lacks technical understanding
- Results from man-made sources
  - Engineered nanoparticles
- Causes hidden and irreversible damage
  - Could accumulate in the body or environment, unbeknownst to consumers and agencies, leading to chronic effects
- Poorly understood by science or responsible agencies
  - Both researchers and regulators face great uncertainty
- Described in contradictory statements from responsible sources
  - Utopian and apocalyptic representations of nano abound

(Sources: Nordan, 2005; Bennett & Calman, 1999)

# Societal Issues

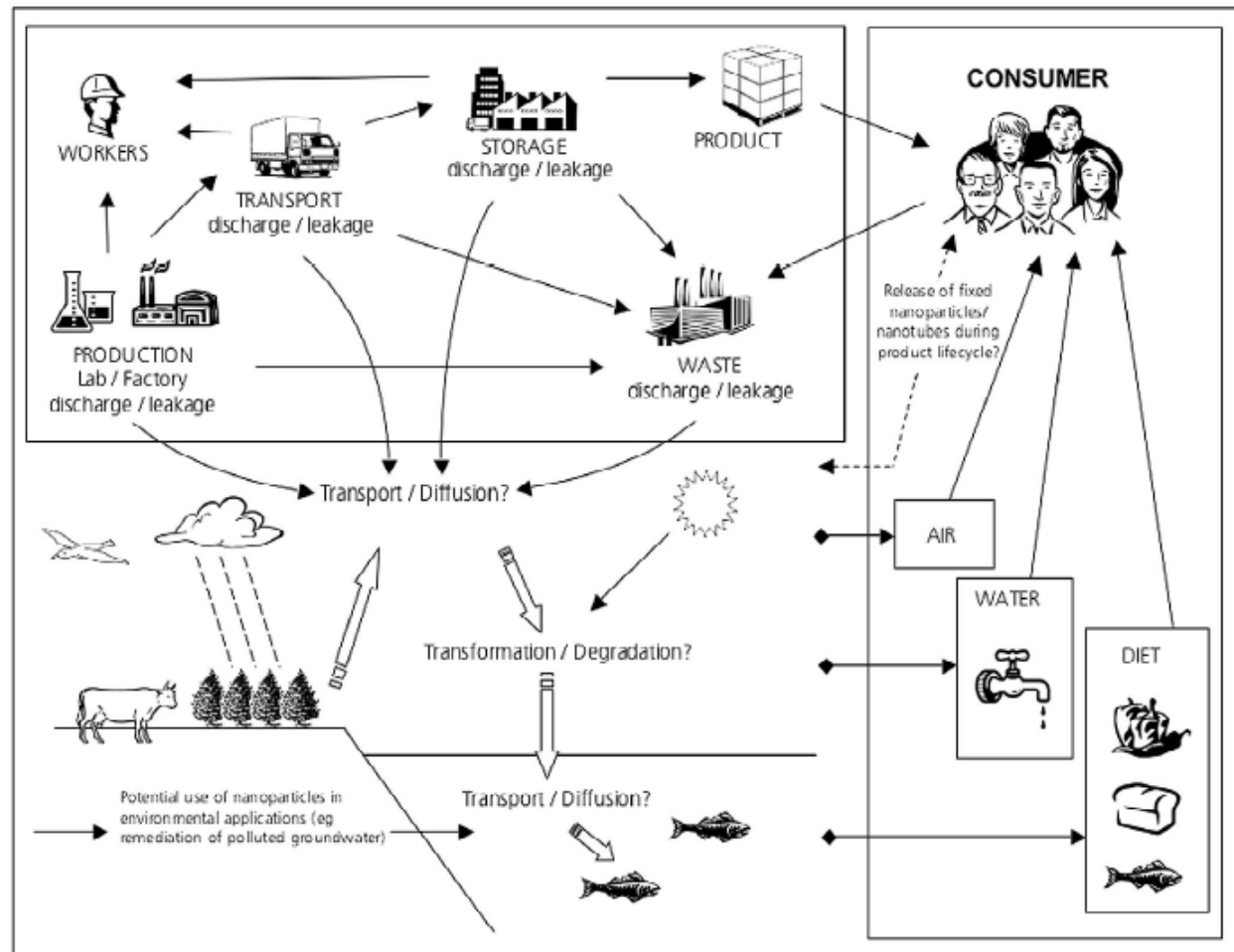
- EHS (Environmental, Health, Safety)
  - Toxicology data
  - Regulations
  - Workplace practices
- Other ethical aspects
  - Privacy, identity, misuse, disruption
- Governance
  - Integrate social research (US Congress)
  - Address “real and perceptual risks” (Nordan, 2005)



- Greater surface areas per mass compared to larger-sized particles of same chemistry
  - Nanoparticles more biologically, chemically active
  - Can be positive and/or negative
- Evidence points towards possible EHS risks of some nanomaterials (Chen et al., 2005; Jia et al., 2005; Oberdorster et al., 2002, 2004)

# Nanomaterials potential EHS diffusion pathways

- EHS impacts dependent on particle properties
- Changes with agglomeration
- Environmental fate of nanomaterials unknown over product lifetime
  - Air
  - Soil
  - Water
  - Plants

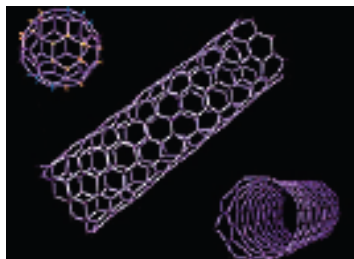
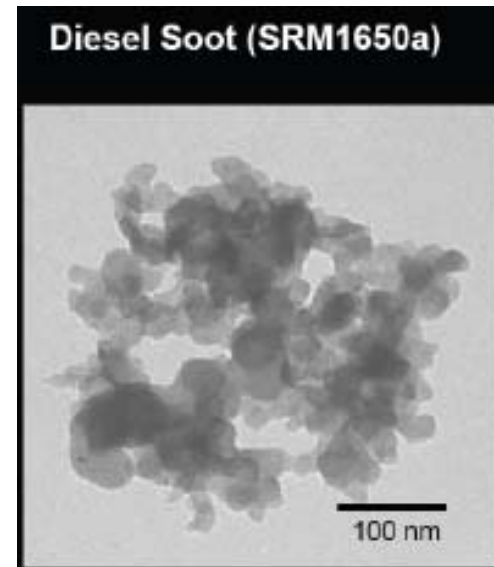
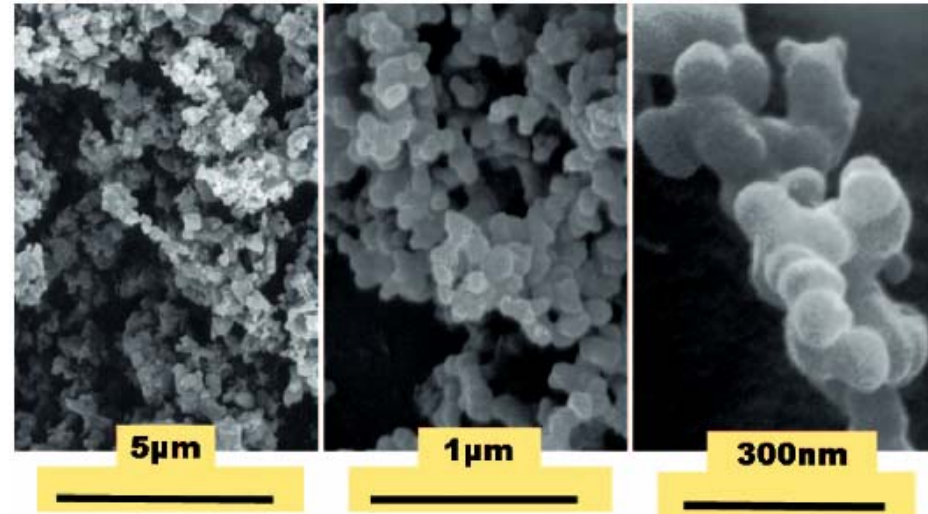


*Dept. of Environment, Food, and Rural Affairs, UK, 2006 (adapted from Natl. Institute Resources and Environment, Japan)*

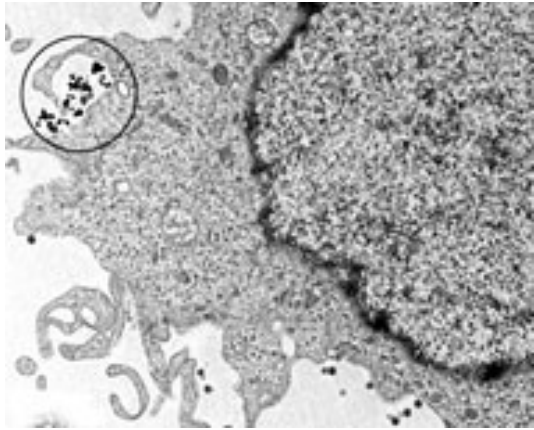


# Limited Baselines for Comparison

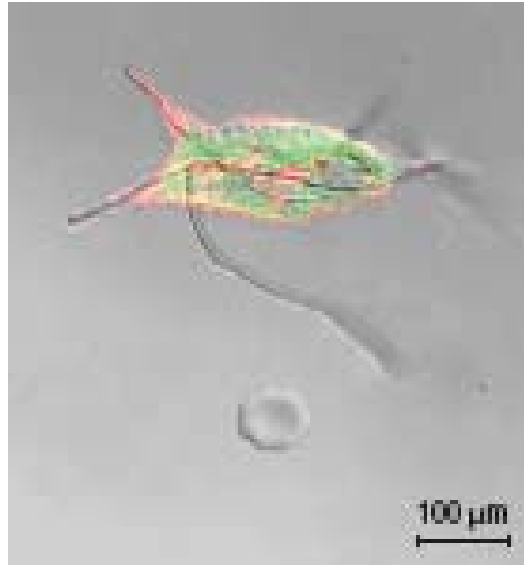
- Incidental ultrafine particles
  - Heterogeneous
  - Primarily carbonaceous
  - High levels of agglomeration
  - Correlated to mortality rates (SwissRe, 2003)
- Engineered nanoparticles
  - Highly structured, uniform in size
  - Reactive surface chemistries
  - May remain mobile longer (EPA, 2005)
  - May increase in toxicity



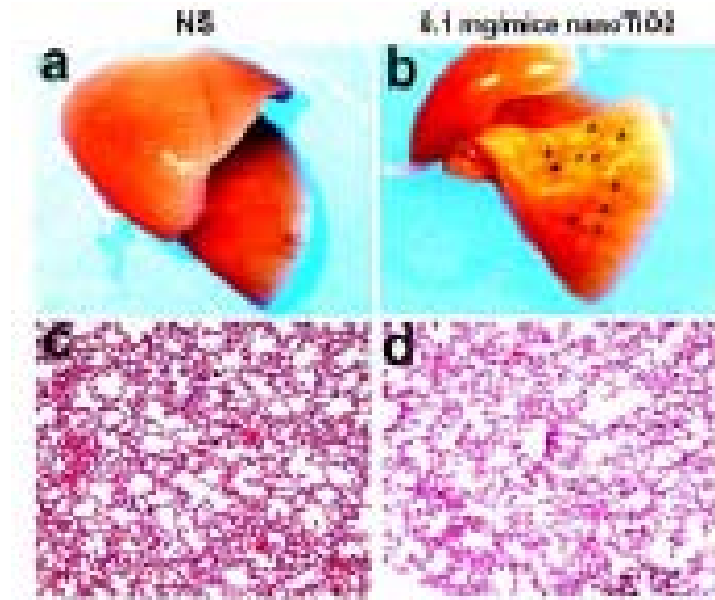
# Biological Response to Nanomaterials



**Mouse microglial cell defends itself from titanium dioxide nanoparticles (Veronesi et al, 2006).**

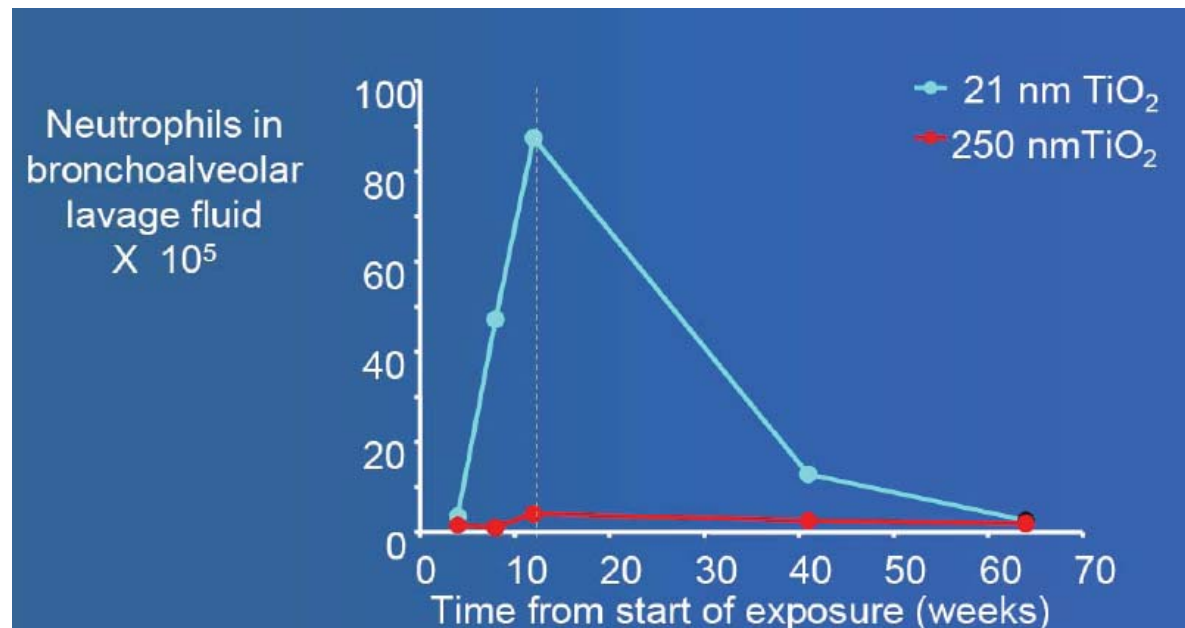


**Rat lung cell attempts to ingest carbon nanotube (Stone & Donaldson, 2006).**



**TiO<sub>2</sub> Induced rat lung cell lesions (Chen et al, 2006).**

**Ability of some particles to cross the blood-brain barrier and to impact the central nervous system (Oberdorster, 2002)**



(Ferin et al, 1992 cited in Bayer, 2006)

# Federal Mandates

## National Nanotechnology Initiative

- Responsible Development of Nanotechnology

## *21<sup>st</sup> Century Nanotechnology Research and Development Act*

- insofar as possible, integrating research on societal, ethical, and environmental concerns with nanotechnology research and development

How should CINT  
engage in these issues?

# How should CINT engage in these issues?

- What is CINT already doing in these areas?
- What could be done better?

# How should CINT engage in these issues?

- Education and preparation?
- Communication and outreach?
- Research practices?
- Management policies?
- Integration of social and scientific issues
  - Criteria
  - Opportunities
  - Challenges



# Workplace Safety

- Issues
  - Possible higher combustibility of some common particles at nanoscale compared to micronscale
  - Uncertain toxicology data, understanding, regulation
  - Uncertainty whether protective equipment is adequate
- Federal Agencies
  - FDA, EPA, NIOSH
  - Communications
  - Volunteer reporting
- Guidelines
  - Factors that can increase potential exposure
    - Liquid media
    - Generating gas phase materials in nonenclosed systems
    - Nonstructured powders
    - Maintenance of equipment and processes
    - Cleaning of dust collection systems



| Group   | Date           | Document  |
|---|----------------|---|
| European Commission (EC)  | June 2005      | Nanosciences and nanotechnologies: An action plan for Europe 2005-2009  |
| U.S. National Institute for Occupational Safety and Health (NIOSH)    | September 2005 | Strategic Plan for NIOSH Nanotechnology Research  |
| Consortium of researchers   | October 2005   | Principles for Characterizing the Potential Human Health Effects from Exposure to Nanomaterials: Elements of a Screening Strategy                               |
| U.S. Environmental Protection Agency (EPA)                            | December 2005  | External review draft of nanotechnology white paper   |
| U.K. Department for Environment, Food and Rural Affairs (DEFRA)       | December 2005  | Characterizing the risks posed by engineered nanoparticles: A first UK Government research report   |
| EC Scientific Committee on Emerging and Newly-Identified Health Risks | March 2006     | Opinion on the appropriateness of existing methodologies to assess the potential risks associated with engineered and adventitious products of nanotechnologies |
| Woodrow Wilson International Center for Scholars                      | July 2006      | Nanotechnology: A Research Strategy for Addressing Risk   |